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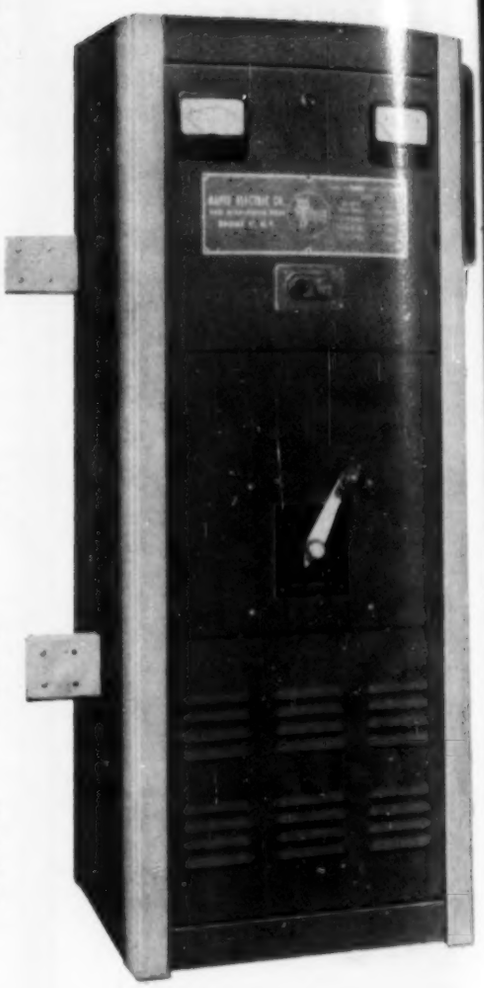

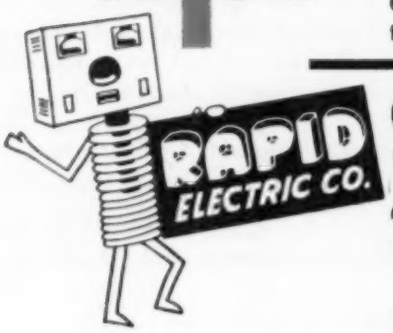

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Editorial

Impediment to Chemical Education

PROFESSIONAL educators are responsible in large measure for the prevalence of mediocre chemical teaching in secondary schools. These products of teacher's colleges and normal schools place great emphasis upon methods and techniques of teaching to the neglect of the subject matter to be taught. They have had conspicuous success in persuading most states to incorporate this philosophy into laws pertaining to the administration of public schools. The result of this is that well educated chemists, even those with doctor's degrees, may not teach chemistry in high school without evidence of the prescribed training in educational theory and practice. Now methodology may be important in the training of teachers for kindergarten and primary grades, but students in the third year of high school deserve chemistry teachers with some knowledge of the subject. It is the paucity of such teachers more than anything else that has led to the relative decline in the enrollment of students in high school chemistry classes. The majority of boys and girls decide upon a career before high school graduation. They are attracted and inspired by enthusiastic, well informed teachers proud of their field of scientific specialization and their profession. Students are discouraged by pedagogues and choose to avoid their courses. Since we once satisfied the requirements and received a degree in education, we speak with some personal experience in saying that educational methodology will never be a substitute for scientific knowledge as a qualification for teaching.

The foregoing insistence upon knowledge as a requirement for good teaching should not be taken to mean that this is the only qualification. The saying that teachers are born and not made suggests that desire to teach and an intense interest in young people and their development are natural attributes of successful teachers. No doubt good teachers must be adept in human relations. No one will contend that proficient chemists are necessarily good teachers, but there needs to be wider recognition of the fact that skillful high school chemistry teachers must have considerable knowledge of their science. Economic factors affect the supply of chemists who would teach; professional educators determine who will be permitted to teach. —RMB

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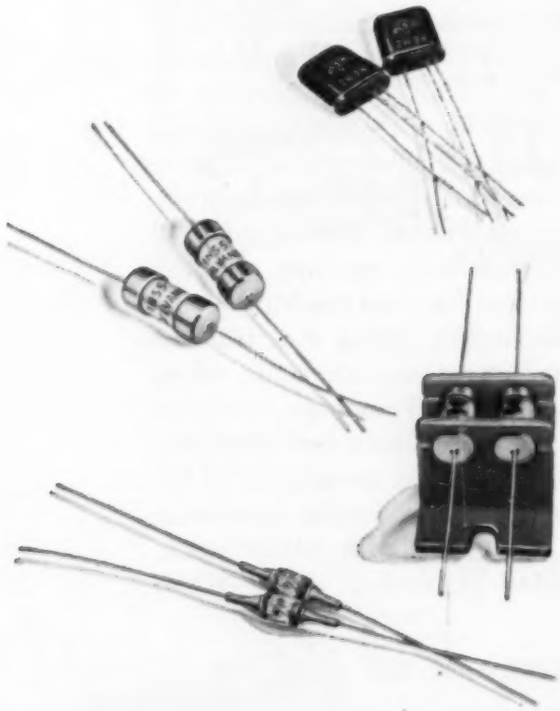

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ELECTROCHEMICAL AND ELECTROMETALLURGICAL INDUSTRIES OF CANADA

Part IV. Saskatchewan, Alberta, British Columbia, The Yukon and Northwest Territories[1]

A. C. Holm[2]

Introduction

Resuming our tour westward from Ontario and Manitoba, we enter the second of Canada's so-called "Prairie Provinces"—the Province of Saskatchewan (the others being Manitoba and Alberta). Predominantly agricultural in the past, the economy of these Prairie Provinces is gradually changing toward greater industrialization as their great natural resources, in particular petroleum, natural gas, lignite and coal, receive increasing development.

The Province of Saskatchewan

In Saskatchewan's total area of 251,700 square miles there is to be found about one-third of the total occupied farm land of Canada. This land produces about 60% of Canada's wheat, in addition to oats, flax, barley, and rye, and supports large stocks of cattle. Agriculture provides the main livelihood for the population of 861,000, for manufacturing within the province is largely comprised of food processing operations.

Minerals

The province's mineral resources, which are now undergoing intensive exploration in some areas, may soon become important sources of wealth; chief contenders at the moment are uranium ores, petroleum, and natural gas. In the Precambrian rock formations of Saskatchewan's north country several occurrences of uranium ore have been found recently. One of these, in the Goldfields area on the north shore of Lake Athabaska just south of the 60th parallel, has been brought to the production stage by the Crown-owned Eldorado Mining and Refining Limited, and may prove more important than that company's first mine at Port Radium in the Northwest Territories.

Just south of the 55th parallel, Saskatchewan shares a base-metal mine, the Flin Flon, with its eastern neighbor Manitoba, and all the output from the Saskatchewan workings goes to the copper smelter and electrolytic zinc refinery of the Hudson Bay Mining and Smelting Company in Manitoba.

In the southern, Great Plains half of the province an intensive search for petroleum and natural gas has brought in several large wells in the past five years. It is expected that Saskatchewan will have sufficient supplies of oil and gas for all its own needs. Should this not be the case, it is probable that gas would soon be piped in from Alberta. The Interprovincial Pipeline already crosses the province, carrying oil from Edmonton to Superior, Wisconsin, at the head of the Great Lakes.

But even without oil or natural gas, Saskatchewan would have ample fuel resources in its huge lignite deposits, estimated to contain about 12 billion tons. These are now being worked by strip mining on a scale of about 2¼ million tons per year, mainly at Estevan near Saskatchewan's southeast boundaries.

In the southerly part of Saskatchewan there are also to be found large deposits of sodium sulfate, salt and potash, and magnesium salts, all of which are of potential interest to the electrochemist. For example, in six lakes surveyed by the Provincial Department of Natural Resources the waters are estimated to contain a total of over 5 million tons of magnesium in solution, in concentrations ranging from 0.16 to 2.3% (sea water, for comparison, runs about 0.13% magnesium). These nonmetallic mineral resources, in combination with abundant lignite, gas, and oil as cheap fuels for thermal power, are Saskatchewan's best-known prospects for an electrochemical industry, which the province now lacks. But in the northern areas, underlain by Precambrian rocks, there is a good possibility of uncovering further metallic minerals; here also are a number of potential hydroelectric power sites.

Electric Power

Saskatchewan's hydroelectric power resources total at present only 112,000 hp, and most of that is generated and produced for private industry, mainly in the north for the neighboring province of Manitoba.

However, the settled southern part of Saskatchewan is well served by thermally-generated electricity. That thermal power capacity totals about 274,000 hp, but its annual production, about 550,000,000 kwhr now, is a little less than that of the hydroelectric stations because of the small amount of manufacturing or processing industry which they serve.

The provincially-owned power corporation operates most of the thermal plants, with a total installation of 112,000 kw in steam generation and other considerable amounts in gas-engine and diesel plants. Among its larger installations are those of 64,000 kw at Saskatoon, 22,750 kw at Estevan, and 22,200 kw at Prince Albert.

The city of Moosejaw is served by the 37,500-kw plant of the National Light and Power Company, while the capital city of Regina operates its own steam plant, of 55,000 kw.

Natural gas is now being brought into the province, and new hydroelectric possibilities are being studied in the north.

[1] This concludes this series of articles on Canada. Part I appeared in the November 1953 JOURNAL, Part II in January 1954, and Part III in February 1954.

[2] Canadian Regional Editor of the JOURNAL. Shawinigan Chemicals Limited, Shawinigan Falls, Quebec, Canada.

The Province of Alberta

Minerals

Of the three "Prairie Provinces," Alberta appears to be the most richly endowed in natural resources. Petroleum and natural gas are the greatest of these, and much has been written about the spectacular discoveries of oil and gas here in the past six years. But Alberta also produces more coal than any other province in Canada—about 41% of the nation's total. It also has sizable production of salt, limestone, clay, and sulfur, and undeveloped reserves of oil-bearing sands, gypsum, and shale, the latter suitable for rock wool production. These minerals, in particular petroleum and coal, enable Alberta to occupy third place behind Ontario and Quebec among Canada's mineral-producing provinces, Alberta accounting for over 15% of the nation's total mineral output in value.

As Alberta includes part of the Rocky Mountains within its boundaries, it is generously provided with hydroelectric power resources. At present about 55% of its power capacity is hydro, the balance being derived from its abundant cheap fuels.

So far, despite the abundance of minerals and of power, only two electroproducts industries have located in Alberta: a caustic soda-chlorine plant has just been completed, and two firms operate electric steel-melting furnaces in the province.

Alberta's area (255,285 square miles) and population (1,002,000) is, like that of the other "Prairie Provinces," largely devoted to agriculture, particularly in the southern "prairie" and central "parklands" sections. Grains, dairy, and meat products account for much of the province's present income. Forests, mainly in the north, cover about half the area, and lumber is an important product. But the real wealth of the province has just begun to be tapped: oil reserves are estimated at over 1.8 billion barrels, and some 4380 wells now produce a daily average of about 253,000 barrels of crude oil. Natural gas, with estimated reserves of at least 8 trillion ft^3, is being produced at a rate of over 100 billion ft^3 per year. Petrochemical industry is rapidly growing within the province, and it is highly probable that pipelines will soon carry its natural gas far to the west and to the east, and even into the United States. Coal reserves run about 47 billion tons, and production is at a rate of about 8 million tons per year, about 82% bituminous and 18% sub-bituminous coal. And still untouched are the bituminous sands, bearing quantities of oil variously estimated at from 100–250 billion barrels!

Electric Power

With 400,000-hp capacity now installed, a little more than half of it in hydroelectric plants, the province of Alberta has still hardly begun to use its natural resources of water power, coal, and natural gas. Alberta has tapped only a little more than an eighth of its hydraulic power potential, and only minor fractions of its coal and natural gas resources. It has become, in the past seven years, one of the major oil-producing areas on the continent.

Most of the thermal power being produced now is fueled by natural gas, but provincial authorities expect that local coal will be used in immense new power plants in the near future. As for water power, there is 700,000 hp waiting to be developed on the Athabaska River alone, near already established settled areas.

All of the present hydroelectric plants are owned by Calgary Power Company, and draw water from the slopes of the Rockies in the southern part of the province. The largest is of 62,000 hp, and new plants totalling 42,000 hp are under construction.

Following are the present electroproducts industries of Alberta.

Chlorine-caustic soda.—Western Chemicals Ltd., of Calgary, has just brought into operation at Duvernay, Alberta, the first chlorine plant in Western Canada. This plant, reported to involve an investment of $3.5 million, is being designed for an ultimate daily output of 20 tons chlorine, 24 tons caustic soda, and 10 tons muriatic acid. Initially the production is expected to be about 5000 tons per year of caustic soda and 4000 tons per year of chlorine. The salt will be obtained from wells drilled at the site, while power for electrolysis will be generated by means of natural-gas engines. Caustic soda and chlorine will presumably be consumed by petrochemical and pulp and paper industries in Western Canada, while the hydrochloric acid will be used in oil-well drilling operations.

Electric steel.—Two firms which melt steel in electric furnaces in Alberta are: Riverside Iron Works Ltd., Calgary, which has one 1½-ton electric steel furnace; and Foothills Steel Foundry and Iron Works, Calgary, which operates one ½-ton electric steel furnace.

The Province of British Columbia

British Columbia, the most westerly province of Canada, in many respects ranks third in the list of the nation's ten provinces. Thus it is, after Quebec and Ontario, the third largest in area (366,255 square miles) and population (1,230,000), in value of total production, in manufactures, and in electric power production. In pulp and paper production it also ranks third, but expansion programs now under way or planned in B. C. make this area the fastest-growing in the world in this field at present. In sawmill products (lumber, plywood, shingles, etc.) British Columbia leads all provinces by a wide margin; this is also true of its fisheries. In mineral output, B. C. and Alberta compete closely for third place, each accounting for some 13–15% of total Canadian mineral production.

In value and variety of electrochemical and electrometallurgical products, British Columbia ranks closely behind Quebec and Ontario at the present time. In respect to the potential for further development of electroproducts industries, B. C. would appear to outstrip all provinces except Quebec because of the following favorable factors:

1. Only 13% of its hydroelectric power potential has been developed, and the undeveloped resources, estimated at over 12,500,000 hp, are greater than those of any other province except Quebec.

2. Mineral resources, especially of metals, are enormous, and vast tracts of land have still not been adequately explored for minerals.

3. British Columbia's lengthy, indented coastline on the Pacific Ocean permits cheap transportation of ores and other raw materials into the province, and of products out of the province.

4. The rapidly growing industries of the United States Pacific Coast offer a promising market for B. C. products.

Minerals

While coal and placer gold have been produced in British Columbia for almost 100 years, the province has achieved world fame for its base-metals output during the past fifty

The Consolidated Mining and Smelting Company's power plant at Brilliant, British Columbia, on the Kootenay River near its confluence with the Columbia. This 111,000-hp plant, completed in 1944, is one of five supplying power for the metallurgical and chemical operations of this company, which produces 460 tons of lead, 500 tons of zinc, 35,000 ounces of silver, and 1770 tons of chemical fertilizers per day, in addition to other metals.

years. Up to the end of 1951, mineral output of B. C. was estimated to total over $3 billion; of this, over 85% has been in metals, chiefly lead, zinc, copper, gold, and silver. The Sullivan mine at Kimberley, B. C., operated by the Consolidated Mining and Smelting Company of Canada Limited, is rated the world's largest producer of lead-zinc ore, with which is associated also iron, gold, and silver. "Cominco" has also developed other ore bodies in B. C., and treats ores from about 100 different properties on a custom basis. Among its products, besides lead and zinc, are also cadmium, bismuth, antimonial lead, indium, tin, and during the last war, mercury, antimony, and magnesium. Copper concentrates are produced by several companies and shipped to smelters in the United States. Magnetite and hematite deposits are known at various points in B. C., and some of the former are in production. At least two tungsten ore producers are active, and tungsten ore is now being smelted in the province to tungsten carbide. Placer gold is still an important mineral product.

In nonmetallic minerals, B. C. has good coal resources estimated at about 2 billion tons, chiefly bituminous. Petroleum has been found in moderate amount, but natural gas seems to be abundant, particularly in the Peace River field near Fort St. John. A new pipeline now brings oil into Vancouver from Alberta wells. A pipeline to transport B. C.'s natural gas southward into the United States is under consideration. Two deposits of high-grade, long-fiber asbestos are being brought into production. The province also produces cement, sand, gravel, building stone, clay products, and peat moss.

Electric Power

British Columbia, traversed by three distinct mountain ranges, and having a high average rate of precipitation, affords good opportunities for hydroelectric power development. It is the source of many great rivers, e.g., the Columbia, Fraser, Skeena, Thompson, Kootenay, Stikine, Liard, and Peace Rivers. These streams, with their countless tributaries, drain an area equal to about one-tenth of the entire North American continent.

The Pacific Coast province of Canada stands third only to Quebec and Ontario in the total of electric generating capacity installed—about 1,800,000 hp, almost all of it hydroelectric—and second only to Quebec in the volume of hydraulic potential still awaiting development.

Now under construction, the first three of its ultimate 16 units to be completed this year, is the largest and most dramatic of all Canada's hydroelectric developments yet to be undertaken. That is the Kemano project of the Aluminum Company of Canada, which when completed would have a capacity of 2,240,000 hp, its turbines housed in a great cavern carved out of a mountain and driven by water falling half a mile in a 10-mile tunnel from a man-made lake formed by diversion of East-flowing mountain-top rivers. That power is to be transmitted over the mountains to Kitimat, on an arm of the ocean, to a new aluminum smelter. The first potlines are to be in operation later this year, with the initial 420,000 hp.

Still greater, by far the largest power project in the world, if it comes to fruition, is the projected development of more than 4,000,000 hp near British Columbia's northern boundary, where the Frobisher-Ventures interests are planning to divert the immense headwaters of the Yukon and adjacent streams, to drop them into the Pacific in order to power a huge new smelting industry.

And studies are continuing on the proposal to harness the mighty Fraser River in a series of steps to produce about 2,000,000 hp.

Last year alone, British Columbia saw the addition of more than 335,000 hp to her electrical capacity. The largest new development consisted of two of the ultimate four machines, of 105,000 hp each, installed by Consolidated

Mining and Smelting at Waneta on the Pend d'Oreille River. Two more machines were added to the John Hart development by the B. C. power commission, to give that plant a total of 168,000 hp. A fourth 62,000-hp unit, of the ultimate 10, was installed by B. C. Electric in the Bridge River development, and another is to be added this year.

There are now 33 hydroelectric developments, of more than 2,000 hp each, operating in the province. This year, 482,000 hp is to be added to the installed capacity. Thermal plants in the province are rated at only about 43,000 hp.

Electrochemical and Electrometallurgical Products of British Columbia

Electrolytic lead.—At the Trail smelter of the Consolidated Mining and Smelting Company of Canada Limited, lead concentrates are smelted to bullion in blast furnaces, and the bullion electrolytically refined by the Betts process. This plant is the world's pioneer electrolytic lead refinery, started in 1902. Capacity today is about 460 tons daily of refined lead.

"Cominco" had its origin in a smelter built at Trail, B. C., in 1895 to treat local gold-copper ores, which was later acquired by the Canadian Pacific Railway. A blast furnace was installed to produce lead bullion, and, in 1902, the Betts cell process was inaugurated to refine this bullion on a scale of 50 tons per day, the first plant of its kind in the world. In 1906 this smelter-refinery amalgamated with several other companies and adopted the title of Consolidated Mining and Smelting Company of Canada Limited.

In 1910 Cominco acquired the Sullivan Mine, the ore of which is a complex, intimate mixture of galena, marmatite (zinc-iron sulfide), pyrrhotite, siliceous gangue, and small quantities of silver, cassiterite (tin oxides), cadmium, indium, etc. While this ore was utilized for lead and zinc production on a relatively small scale, it was not until the advent of differential flotation in 1920 that separation of the various constituents of the ore became commercially successful. From this date on Cominco has steadily expanded, until it has today at Trail, B. C., one of the largest and most ingeniously integrated smelting plants in the world. Total sales in 1952 are listed at over $153 million. The power load is about 300,000 hp.

The Sullivan ore is today treated on a scale of about 11,000 tons per day by sink-and-float and flotation processes to produce about 500 tons per day of 65% lead concentrates and 800 tons per day of 48% zinc concentrates. An iron-sulfide concentrate is also recovered and stockpiled at Kimberley, and about one ton per day of a 60% tin concentrate is also obtained. These concentrates are then shipped from Kimberley, near the mine site, to the Trail smelter about 200 miles away on the Columbia River.

Treatment of the lead concentrates consists in mixing with other raw materials, drying, sintering, and reduction with coke in the blast furnace. The bullion produced is first drossed to remove copper, then poured into anodes for electrolytic refining. The electrolyte is a solution of lead silico-fluoride and hydrofluo-silicic acid, which is circulated through the cells at about 4 gal/min. Anodes are electrolyzed for six days, yielding two crops of lead cathodes. The cathode lead is melted and blown with air to remove traces of tin, arsenic, and antimony. The product, "Tadanac" brand lead, is 99.997% pure.

Gold and silver.—Anode mud from the electrolytic lead cells is treated to recover gold, silver, and other metals. Furnacing, fuming, and cupellation produce first a gold-silver alloy known as Dore metal, which is separated by electrolysis in Thum cells with silver nitrate electrolyte into gold (975 fine) and silver (999.7 fine). The silver refinery has a capacity of about 15 million oz per year.

Bismuth.—In the treatment of the anode mud, a lead-bismuth metal is recovered, drossed to remove copper, treated by the Parkes process to recover gold and silver, and then refined electrolytically to remove lead. The residue is refined to high purity bismuth. Capacity is about 0.3 tons per day.

Electrolytic zinc.—Cominco and Anaconda pioneered electrolytic zinc in America during World War I. Cominco's refinery at Trail started in 1916 with a capacity of 60 tons of zinc per day. Since then it has grown into the largest electrolytic zinc plant in the world, with a capacity of 500 tons per day, and up to the end of 1952 had produced 3½ million tons of the metal.

At Trail, zinc concentrates are roasted in Cominco's own design of suspension roaster. This calcine is then dissolved in dilute sulfuric acid, and the zinc sulfate solution purified before electrolysis. In the cell room, the tanks are arranged in 65 units, each unit comprising four cascades of 9 cells each. Cells are of concrete with acid-proof linings. Lead alloy (0.75% silver) anodes are used, and the zinc is deposited on aluminum cathodes and stripped off every 24 hours. D-C equipment, of 73,000-kw capacity, consists of 7 motor-generator sets, 10 rotary convertors, 4 mercury arc rectifiers, and 3 ignitrons.

Cominco has recently pioneered in America a 300-ton induction furnace for melting zinc cathode sheets, the largest of its kind in the world. It was designed and built by Societa Italiana Construzioni Elettrotermiche of Milan, Italy.

Cadmium.—During the purification of the zinc sulfate electrolyte, cadmium is precipitated and recovered, and later electrolyzed in a similar manner as zinc to produce the pure metal. Capacity is about one ton per day.

Indium.—This is the latest metal to be recovered by Cominco on a commercial basis. An electrolytic process is used in its recovery.

Tin.—Cominco recovers by an electrothermal process about one ton per day of tin from its ores. This is the only production of tin in Canada.

In addition to the above metals, Cominco also produced during World War II electrolytic magnesium and electrolytically refined antimony on relatively small scales. The former utilized a cell of Cominco's own design, while the latter process consisted of electrolyzing crude antimony anodes in a sodium-antimony sulfide electrolyte. These processes, now no longer operated, illustrate once again Cominco's leading role in electrometallurgical research and production.

Electrolytic hydrogen and oxygen.—Production of these gases by Cominco may be traced to the sulfur content of its ores and the need to eliminate obnoxious sulfur dioxide fumes from its smelter stacks. From these fumes Cominco now produces some 1200 tons of sulfuric acid and 1770 tons of fertilizers daily. Part of this SO_2 is converted into ammonium sulfate fertilizer, and for this purpose ammonia, and hence hydrogen, is required. Part of this hydrogen is obtained by Cominco by the electrolysis of water. By-product oxygen is consumed in the various metallurgical operations.

Cominco uses electrolytic cells of its own design with a novel monolithic cell top; some 3215 such cells are provided. The electrolyte is a 28% caustic potash solution. Cells

operate[d] 10,000 amp, d-c power being supplied by three 670-volt and seven 830-volt mercury arc rectifiers of 10,000-amp rating. The hydrogen has a purity of 99.9%.

Tungsten carbide.—The Macro Division of Kennametal, Inc., at Port Coquitlam, B. C., went into production early in 1953 on tungsten carbide. This plant is designed to use the McKenna direct smelting and refining process on which Kennametal, Inc., (Latrobe, Pennsylvania) has received Canadian and U. S. patents. Operations consist of ore dressing, preparation of tungsten concentrates, and direct smelting in an electric furnace. Tungsten ores mined in British Columbia will be used, as well as foreign ores. This is the only producer of tungsten carbide in Canada.

Electric furnace steel.—The following firms in British Columbia melt steel in electric furnaces for castings or ingots:

A-1 Steel and Iron Foundry, Ltd., Vancouver, one ¼-ton furnace.

Britannia Mining and Smelting Company, Ltd., Britannia Beach, one 5-ton electric furnace.

Consolidated Mining and Smelting Company of Canada, Trail, one 1-ton and one 6-ton electric furnace.

Reliance Foundry Company, Ltd., Vancouver, one ½-ton and one 1½-ton electric furnace.

Vancouver Engineering Works, Ltd., Vancouver, one 2-ton and one 1-ton electric furnace.

Vancouver Steel Company, Ltd., Vancouver, one 12½-ton furnace.

Victoria Machinery Depot Company, Ltd., Victoria, one 1¼-ton furnace.

Canadian Sumner Iron Works Ltd., Vancouver, one 1-ton and one 2-ton electric furnace.

Aluminum.—While there is as yet no production of aluminum in B. C. Province, it is expected that the first ingots from the new smelter of the Aluminum Company of Canada, Limited, at Kitimat, B. C., will be poured by the middle of this year.

To meet the increase in civilian demand for its products and the intensified defence requirements, the Aluminum Company of Canada, Limited, embarked in 1951 on the construction of a new aluminum smelter in the wilderness of B. C. at Kitimat, 400 miles north of Vancouver. Construction has been underway for nearly three years and the target date of aluminum production by midsummer 1954 is apparently assured.

The project has been so designed that the full development of the site is possible in successive stages. Alcan is only committed to the first stage of the ultimate development at the present time. This first stage involves the construction of potlines with an initial output of 83,000 metric tons per annum. However, an additional smelting capacity of approximately 182,000 tons per annum is possible at Kitimat without substantial enlargement of the Hydro Works and transmission lines now existing. The additional cost of the augmented production is estimated to be less than one-third of the cost per ton of the initial installation.

The full output of 500,000 tons aluminum per annum could be attained at a cost estimated to be lower than can be achieved elsewhere. The company is unable to predict when the further developments might be undertaken, and only the 83,000 tons production is now authorized.

This smelter, if carried to its ultimate capacity of some 500,000 metric tons of aluminum per year, would become the largest aluminum smelter in the world. Its output alone would then equal the combined capacity of Alcan's present four other smelters in Canada, which are all located in the Province of Quebec.

Other possible electroproducts industries for B. C.—While there have been no definite decisions announced as yet, speculation is rife that two or three further electroproducts industries may locate within the province in the not too distant future.

Caustic soda and chlorine.—Hooker Chemicals has acquired a site in Vancouver, B. C., and has under consideration a project to manufacture there caustic soda and chlorine to supply B. C.'s growing pulp and paper industry. At present Hooker supplies these raw materials to B. C. mills from its Tacoma, Washington, plant. The establishment of this plant presumably depends on the size of the future markets in the province.

Electric pig iron.—The availability of cheap hydroelectric power and of various iron ores has led several firms to investigate the possibility of producing pig iron in an electric furnace in B. C., where the demand for pig iron is too small to support the conventional blast furnace. One location considered has been the Vancouver area, using ore from Texada Island or Zeballos. Another possibility is the utilization of the 30 million tons of pyrrhotite tailings accumulated by the Consolidated Mining and Smelting Company at Kimberley, B. C. The most recent proposal contemplates production of iron in the northwestern corner of B. C. on Taku Inlet near Tulsequah, using low-grade ores from the Klukwan deposits near Haines, Alaska. This latter project would be part of a tremendous electrometallurgical development in this area which is said to be contemplated by the Frobisher interests, and is discussed below. All of these proposals are, as far as is known, only in the speculation stage as yet.

Electrometallurgical project of Frobisher-Ventures in Northern B. C. and the Yukon.—Much interest has been aroused by proposals advanced by Ventures Limited and Frobisher Limited to develop some 4,300,000 hp of hydropower on the headwaters of the Yukon River, partly in B. C., and partly in the Yukon. This power might be used at various points in the Yukon, the Alaskan Panhandle, or Northern British Columbia to smelt local ores, or foreign ores brought in by vessel. An attractive feature of the plans is that the power apparently can be developed in several stages at reasonable cost for each stage. Possible products are ferroalloys, ferronickel, silicomanganese, electric pig iron, electric furnace refined alumina, cobalt, and base metals. Possible sites mentioned have been on Taku Inlet of the Nakina River near Tulsequah, B. C. (east of Juneau, Alaska); at Atlin, B. C., or Whitehorse, Yukon; and to the south on Alice Arm Inlet, just north of the 55th parallel. The latter location has the disadvantage of a long transmission line from the generating stations, but would avoid the difficulty of a passage through the U. S.-owned Alaskan Panhandle in order to reach shipping lanes. A good deal of careful planning and field surveys have already been completed on this project, and it is probable that more definite announcements as to the plans will be forthcoming in 1954. If the project materializes, it could become by far the largest electric power and electrometallurgical development in the world.

Yukon Territory and the Northwest Territories

Yukon Territory (area 207,076 square miles and population 9000) and the Northwest Territories (area 1,304,903 square miles and population 16,000) comprise all that portion of Canada lying north of the 60th parallel, except for a

small portion of Ungava in the Province of Quebec. These areas represent almost 40% of Canada's total area, while the combined population is less than 0.2% of Canada's total population.

For the electrochemist these regions are of interest mainly for their resources in minerals and water power; they lack any type of electroproducts industry at present.

Minerals

Gold (placer and lode) mining is the predominant activity at present, mainly at Yellowknife in the Territories and on the Klondike in the Yukon. In the Territories, uranium ore is an important product from Great Bear Lake, and petroleum from Norman Wells. Lead-zinc ore occurrences are of promise in the Great Slave Lake area, while to the east in the Keewatin District interesting showings of nickel ore are being investigated. Chances appear good of one or more base-metal mines coming into production in these regions, while much exploration is going on for petroleum and natural gas. In the Yukon, an excellent grade of lead-zinc-silver ore is being mined in the Keno Hill region and sent to Trail, B. C., for smelting. Many promising showings of base-metal ore are currently undergoing investigation in the Yukon, e.g., a copper-nickel discovery at Kluane Lake in the southwest corner of the Yukon Territory near the Alaska Highway. Along the eastern boundary of Yukon Territory in the Selwyn Mountains are found base-metal prospects and iron-ore deposits. Oil exploration is also proceeding briskly in the Yukon. Some coal for local mining operations is extracted at Tantalus Butte in the southwest Yukon.

There is good reason to believe that in both the Yukon and the Northwest Territories there lies concealed a great store of minerals, beyond those already discovered. Most of Yukon Territory is in the Cordilleras, while the central and eastern portion of the Northwest Territories is covered by the ancient rocks of the Precambrian Shield. Experience has shown the Cordilleras and the Precambrian Shield in other parts of the country to be rich in metallic minerals. The MacKenzie River Basin, forming the western portion of the Northwest Territories, is an extension of the Central Plains, which to the south have been found to be rich in oil.

Electric Power

In the Northwest Territories there are many potential hydroelectric power sites which would be adequate for mining and smelting operations on local ores. One of the few developments undertaken to date is found on the Snare River, about 90 miles northwest of Yellowknife Settlement. This project has a capacity of 8000 hp, and serves the Yellowknife mining area. In the Yukon, potential sites are fewer and small. An installation of 3000 hp has been made on the Mayo River, to supply the Keno Hill mining operations.

The total hydroelectric developments in these areas is now rated at 33,000 hp, about 3% of the estimated potential.

This potential does not, however, take into account the proposed Ventures-Frobisher scheme for diverting some of the headwaters of the Yukon River southward into British Columbia, as was discussed earlier in this article. The Yukon Territory would expect to share with B. C. in this scheme, as it would supply at least half of the water resources. This proposal envisages a total hydroelectric development of 4–5 million horsepower, starting on Atlin and Sloko Lakes in Northern B. C., and eventually working northward into Tagish Lake and the Teslin River in the Yukon, with a diversion dam on the Yukon River near Whitehorse. The next stages would involve the Lewes River and the Pelly River, with further dams on the Yukon below Fort Selkirk.

While the full-scale scheme just outlined to develop over 4,000,000 hp would necessitate bringing in tremendous quantities of foreign ores by vessel in order to utilize all of this power, it is quite probable that the project would be inaugurated on a much more modest scale and be based on domestic ores to begin with. For example, a start might be made with, say, 100,000 hp, smelting lead-zinc ores from the Keno Hill region in electric furnaces.

But whatever may be the outcome of the Ventures-Frobisher plans, it seems reasonable to expect that before long, somewhere in the vast reaches of the Yukon and Northwest Territories, the correct combination of minerals and water power resources will be found which will bring into being another Kitimat, Trail, or Flin Flon.

Conclusion

The premise just mentioned, that the availability of water power and of mineral resources, both of these developed or undeveloped, will eventually lead to the establishment of new electroproducts industries, runs like a refrain throughout this series of three articles describing the hydroelectric and electrochemical-electrometallurgical developments in Canada's ten provinces and two territories. Admittedly this is an optimistic assumption, but the history of Canada's electroproducts industries over the past fifty years is replete with examples of just such happy "marriages" of power and minerals. In almost every province and territory of Canada these resources are to be found in abundance, and each region is willing and eager to make use of these resources.

In the first half of the twentieth century Canada's electric power and electrochemical-electrometallurgical industries have made great strides, despite the handicaps of a small population, a generally low level of industrialization, and great geographical distances. Today, with Canada's population growing at a brisk pace, industries bourgeoning, and internal markets expanding, with transportation facilities improved, with her mineral and fuel resources barely scratched, and 75% of her economic hydroelectric power potential still undeveloped, Canada's electrochemists look forward with confidence and enthusiasm to the second half of the century and are beginning to believe that, in electroproducts at least, the slogan is coming true that was first voiced in the early 1900's by Canada's then Premier, Sir Wilfrid Laurier, that "the Twentieth Century is Canada's."

Acknowledgments

The authors of this series of articles, V. G. Bartram (Part I) and A. C. Holm (Parts II, III, and IV), wish to acknowledge the kind assistance of various firms who have supplied information and photographs, and of Mr. D. C. Brown of The Shawinigan Water and Power Company, Montreal, who has contributed most of the sections dealing with electric power developments throughout Canada. Invaluable reference works have also been various publications of the Dominion Bureau of Statistics, in particular "Canada 1953" and the "Canada Year Book 1952–1953," and the book "A History of Chemistry in Canada" published in 1949 for the Chemical Institute of Canada.

degree from magnetite, pass upward by countercurrent in the center of the pipe.

In cooperation with the Bureau of Mines, the Naval Research Laboratory obtained a 500-lb sample of spinning fiber from Canada, and tests were run on a commercial-size Vortrap at the National Bureau of Standards. Results were unsatisfactory because the asbestos had not been disintegrated enough to unlock the magnetite from the fibers. To overcome this difficulty, the Bureau of Mines obtained other samples from Canada and had them prepared at an asbestos-textile plant, where they were passed through breakers, graders, and carding machines. It was presumed that such treatment would release the magnetite grains from the fibers to such an extent that Vortrap separation would be more successful. Prepared samples were then passed through the Bureau of Standards Vortrap, and the resulting asbestos paper appeared to be uniformly white and almost free from magnetic grains. When analyzed, however, it was found that, even after three passages through the Vortrap, the iron content of the paper was still undesirably high. Evidently the magnetite is in very fine grains that adhere to, or become so entrapped in, the fiber that their removal is difficult.

The Bureau of Mines has undertaken a limited program of investigation in this field, which, it is hoped, will solve some of the problems of iron removal.

Development of substitutes for low-iron asbestos.—Remarkable progress has been made during recent years in fiberglass manufacture. Certain glass yarns and tapes are satisfactory substitutes for asbestos in some applications. Glass fibers have satisfactory dielectric properties, but they lack certain physical and chemical properties of asbestos. Glass fibers are used to some extent in conjunction with, or as substitutes for, asbestos in Navy cable insulation, but in general they are inferior to asbestos in resistance to high temperatures, flexure, and chemical action. Recently an aluminum silicate fiber, known as "Fiberfrax," has been announced by the Carborundum Company. It is blown by steam or compressed air after fusion with an electric arc. Fibers will withstand temperatures as high as 2300°F, but no information is yet available on their merits as substitutes for low-iron asbestos in electric insulation. Hydrous calcium silicate is another recent substitute. So much progress is being made in the manufacture of glass and related fibers that their increasing substitution for asbestos in electric insulation is to be expected.

Manufacture of synthetic asbestos.—If asbestos could be synthesized, its iron content could of course be definitely controlled. Asbestos synthesis has been attempted by several government and industry-sponsored laboratories (4–6), but no commercial success has yet been achieved. The Electrotechnical Laboratory of the Bureau of Mines at Norris, Tennessee, has made considerable progress in the synthesis of amphibole asbestos. Fibers are weak and brittle, and research is being conducted on methods of improving their quality. This type of asbestos has limited commercial use and has no place at present in the electric insulation field. Chrysotile has been synthesized in several laboratories, but the fibers made are so small that they can be seen only with an electron microscope. Their elongation from that stage to fibers of spinning length is a long, tedious process. The problem is worthy of continuance in a long-range research program, but no results of practical value are to be expected in the near future.

Summary of the Problem of Supply

According to information now at hand, the most promising solution of the problem of short supply is a probable increase in available quantities of asbestos, the iron content of which is low or can easily be reduced. The British Columbia deposit and others now in prospect offer reasonable hope of larger supplies. Next in importance is the de-ironing of Canadian asbestos. Development of satisfactory substitutes is of almost equal rank, while synthesis is the least promising. The instability of the situation is manifest. New factors may appear at any moment, and the avenues of approach that seem most promising today may become subordinate tomorrow.

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A Phlogiston Theory of Corrosion

Otto L. Willbanks[1]

In the sixteenth century Salmon (1) proposed the existence of a philosopher's stone, the use of which could cause the reactions of metals and, indeed, any reaction whatsoever to be accomplished. Berthelot (2) published a method of preparing gold from silver using the philosopher's stone and thus verified its reality. The preparation of the stone itself was not described by either author, but this omission is understandable when the tremendous commercial possibilities of the substance are considered. Later theorists thought of the stone as a mixture of "universal catalysts," each one governing a certain type of reaction. Stahl (3) in 1697 proposed the existence of phlogiston, the substance necessary for fire or, according to modern concepts, oxidation, and this line of reasoning was further extended by Juncke in 1730. Phlogiston was considered to be used up in the reaction, which ceased when the supply of phlogiston was exhausted. Priestly, Cavendish, and Scheele, discoverers of oxygen, hydrogen, and chlorine, respectively, are numbered among the many supporters of the phlogiston theory of oxidation.

It is only logical to conclude that since most corrosion processes involve oxidation, phlogiston must be the motivating factor. It is known that all reactions are reversible to some extent and, hence, there must be an antiphlogiston substance, i.e., a reduction product of phlogiston. This antiphlogiston is named here notsigolhp. If Ph, No, S′, and S″ represent phlogiston, notsigolhp, uncorroded substrate, and corroded substrate, respectively, the general equation for any corrosion reaction may be written as

$$S' + Ph \rightleftarrows S'' + No$$

and the equilibrium expression for the reaction may be expressed as

$$K_{eq} = a_{S''} \times a_{No}/a_{S'} \times a_{Ph}.$$

By the mass law, an increase in the concentration of notsigolhp should bring about a reduction in the amount of corroded substrate. Thus, if notsigolhp could be incorporated into the crystal lattice of active metals in sufficient concentrations, the corrosion of these metals should be eliminated for all practical purposes.

Since the researches of the early investigators were diverted from the phlogiston problem, the isolation of that factor was never accomplished and this is, therefore, the first problem. It is suggested that the search begin in the active metals which corrode easily and therefore must contain large quantities of this substance. Wood, gasoline, and other readily combustible materials might prove a more plentiful source. Phlogiston must be an oxidizing agent since it promotes oxidation and, hence, notsigolhp could be prepared by the reduction of phlogiston. Another line of attack might be to isolate notsigolhp from passive metals or noncombustible materials.

It is easily seen that not only corrosion phenomena, but also any oxidation process can be explained satisfactorily on the basis of the notsigolhp/phlogiston ratio. Applications to other fields are too numerous to consider at this time. This new theory should not be taken lightly as its basis lies in the fundamental concepts of many of those who originated the science of chemistry.

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Current Affairs

Largest Technical Program Planned for Chicago

The Spring Meeting of the Society will be held at the LaSalle Hotel, Chicago, May 2–6, 1954. A large block of rooms has been set aside by the hotel for members and guests. When making reservation requests, which should be sent directly to the hotel, The Electrochemical Society should be mentioned.

Technical Program

The technical program will run from Monday through Thursday, with simultaneous sessions each day because 145 papers are to be presented at the Chicago Meeting.

Five Divisions will hold sessions: Electric Insulation, Electronics, Electrothermic, Industrial Electrolytic, and Theoretical Electrochemistry. Some of the symposia which will be included are: Industrial Electrolytic Division—General, Molten Bath Electrolysis; Electronics Division—Instrumentation, Luminescence, Rare Metals (joint with Electrothermic Division), Screen Applications, Semiconductors; Electrothermic Division—Symposium on Arc Furnaces; Electric Insulation Division—General, Round Table on Casting and Potting Compounds; Theoretical Electrochemistry Division—General, Symposium on Special Methods in Electrochemistry.

The complete technical program will be printed in the April JOURNAL.

Luncheons

At 12:30 Tuesday, May 4, there will be a General Society luncheon, to which the ladies are invited. The speaker will be announced later.

The following Divisional luncheons are scheduled for 12:30 P.M.: Electric Insulation and Industrial Electrolytic, Monday, May 3; Electronics, Wednesday, May 5; and Electrothermic, Thursday, May 6.

General Meetings and Committee Meetings

Tuesday noon, May 4, has been set aside for the General Society luncheon, followed by a short annual business meeting of the Society. The President's Reception and Banquet will be on Tuesday evening. A meeting of the Ways and Means Committee will be held Sunday morning, May 2, and the Board of Directors meeting will be held on Sunday at 2:00 P.M. The Local Section Advisory Committee will also meet on Monday, May 3, at 5:00 P.M.

Plant Trips

While the schedule of plant trips is not yet complete, visits to some of the diverse industrial facilities in the Chicago area are planned. Although it is customary for travel bureaus to list Chicago's famed Museum of Science and Industry as a "point of interest," it has been decided that the exhibits in the fields of electronics and related industries elevate it to the status of a "plant trip." Therefore, this plant trip has been planned jointly with a visit by the ladies to other exhibits of specific interest to them (see below).

Entertainment

An informal buffet dinner and entertainment has been arranged for Monday evening, May 3. The President's Reception and Banquet is scheduled for Tuesday evening, May 4, and will be followed by dancing. Since everyone likes to have one evening in which to be "out on the town," nothing has been scheduled for Wednesday evening. However, in view of its success in previous years, a Section "Q" session has been arranged for late Wednesday evening, May 5, as something to "come back to." While no formal entertainment is planned, facilities will be provided for "self-amusement," always a favorite Electrochemical diversion.

Ladies' Program,

Plans for the Ladies' Program will include a matinee theater party, a fashion show and luncheon, and small group trips to several places of interest in

SIMON P. GARY
Chairman, Finance Committee

D. V. LOUZOS
Chairman, Plant Trips Committee

BEN FREEBERG
Chairman, Arrangements Committee

Chicago. A trip to the Museum of Science and Industry, jointly with the plant trip, will be of great interest since there are a number of exhibits outside the strictly "scientific" fields. In addition to trips, a morning coffee get-acquainted session on Monday, May 3, to be held at the hotel, will start the program off. The ladies will enjoy attending the General Society luncheon, the President's Reception and Banquet, and the Monday evening informal entertainment, as well as the regular ladies' program events.

If You Like to Explore

The description of "What to See and Do in Chicago" in this account contains only a few suggestions. More complete information will be available at the registration desk in the form of a booklet, "Chicago Welcome." This, supplemented by any taxi-driver's advice, will get you almost anywhere you want to go.

What To See and Do in Chicago

Kaufmann & Fabry Company, Chicago

View of a portion of Chicago's State Street

No trip to Chicago is complete without a visit to some of the city's outstanding points of interest. Arrange to "do" some of them while you're here—you'll be glad you did.

Chicago's museums are among the best in the world. The famed Museum of Natural History and Museum of Science and Industry need no introduction. Not so well known is the Oriental Institute of the University of Chicago; the exhibits here of archaeological findings and works of art from the Near and Far East are of astounding beauty. The museum is considered one of the best arranged in the world. The Illinois State Historical Society Museum (at North and Clark) has the most complete collection on Lincoln in existence. The Art Institute, at Adams and Michigan, numbers among its collections a lovely Jade Room, and an extremely large Modern Painting group. Near the Museum of Natural History (south of Roosevelt Road in Grant Park) are the Aquarium and Planetarium. The Planetarium lecture for May will be "The Astronomer's Workshop."

Also of interest to visitors are the many colleges and universities in the area. In Chicago itself, the University of Chicago, De Paul University, Loyola, Roosevelt College, and the Medical and Law Colleges of the University of Illinois, and Northwestern University are outstanding. The New Medical Center, on the West Side, is an excellent example both of medical building and of slum clearance. Technology Center, home of Illinois Institute of Technology and Armour Research Foundation, is another outstanding example of slum clearance, as well as an education and research center. Northwestern University, in Evanston (about 14 miles north of the Loop), has on its campus the Technological Institute and features a monthly theater production by the School of Speech. Within the Loop area are the Chicago Public Library and the John Crerar Library, both at Randolph and Michigan. The Dramatics School of the Art Institute features monthly productions in the Goodman Theater, on Adams Street in Grant Park.

In your less serious moments, you may want to see some of the current plays and movies. There are five legitimate theaters and numerous motion-picture theaters in the Loop area, within walking distance of the hotel. Orchestra Hall (Adams and Michigan) and the Civic Opera Building (Madison and Franklin) are also nearby. When you arrive, information about current offerings at Loop entertainment spots will be available at the registration desk. If you're interested in something "different" in entertainment, the Playwright Theater, at North Avenue and La Salle Street, features the unusual and seldom-played. A complete list of the foreign films playing in Chicago will also be available at the registration desk.

Which brings us to night clubs and restaurants. You'll like the special La Salle steak dinner served "to order" at the La Salle Hotel, and think you should try it either Wednesday evening, or at some other time during your stay. For other interesting meals, try Le Petit Gourmet, at 619 North Michigan (French); Pizzeria Uno, at Rush and Ohio (pizza supreme); the Red Star Inn (German food of exceptional quality), at 1538 North Avenue; Jacques French Restaurant, at 900 North Michigan; Lido's, upstairs at Clark and Washington (the best Italian food in the Loop); and Gus's, 400 North North Dearborn (specialty: green noodles. Try some!). Excellent American food is obtainable at Carder's, between Washington and Randolph on Dearborn (no cocktails); The London House, 360 North Michigan; George Diamond's Steak House, 512 South Wabash; and Barney's (Yes, Sir, Senator!), at Randolph and Halsted Streets. For a meal you really can't finish, try the Sirloin Room of the Stock Yard Inn, at 4178 Halsted Street in the stockyards district.

Frankly, those who should know *don't* recommend any night club on West Madison Street, west of the river, on

State Street between Van Buren and Roosevelt or on Clark Street between Kinzie and Division. They don't recommend Calumet City, either. And if you try one of these—don't say you weren't warned! If you like entertainment with your meals, try the Lotus Room at the La Salle Hotel. If you like meals with your entertainment, Chez Paree, at 610 North Fairbanks, provides them. For good Dixieland—Jazz, Ltd., 11 East Grand Avenue. Like swing? It's usually available at the Blue Note, on Madison Street just west of Dearborn. For that quiet, late-evening drink, with a bit of fun on the side, drop into the Gay Nineties Tap, in the La Salle. If you like German chamber music, have a drink in the Rathskeller of The Old Heidelberg, on Randolph near Michigan; you'll not be bored a minute! Current attractions in Chicago's night clubs and supper clubs will be listed at the registration desk.

You might enjoy a visit to a television or radio studio. WMAQ and NBC-TV broadcast from the Merchandise Mart (which, by the way, is a good spot to visit anyway). WGN and WGN-TV are located on Michigan Avenue, just north of the Tribune Tower. WBBM broadcasts from the Wrigley Building. The Garrick Television Theater, on Randolph Street in the Loop, has several shows daily. If you'd like to see any specific show, write to the appropriate station; or if you decide at the last minute, inquire at the registration desk and the registrars will try to get tickets for you.

If you arrive on Sunday, you may be interested in visiting one of Chicago's outstanding churches. Within the Loop, The Chicago Temple at Clark and Washington has services at 11:00 A.M. and 7:30 P. M. New St. Peter's, Chicago's newest Catholic church, is on Madison Street between Dearborn and Clark Streets. The famous Moody Memorial Church, on North Avenue just north of Clark Street, has services at 11:00 and 7:00. The First Congregational Church, one of Chicago's most beautiful, is located at 1613 West Washington Boulevard; the morning service is at 11:00.

Other things you may want to see while you're here include Buckingham Fountain, in Grant Park at Van Buren (it's lighted from 9:30 to 10:00); The Chicago Water Tower, at 800 North Michigan; a view of the city from the Tribune Tower or the Board of Trade Building; or the interior of the Board of Trade Building. You may want to take a brief boat trip on Lake Michigan. They leave from the Michigan Avenue bridge, and there's one every hour. Trips are one or two hours long. The bridge itself, by the way, is famous as the site of Fort Dearborn

And of course, no visit to Chicago is complete without a shopping trip—at least, for the ladies. Seven modern department stores on State Street, within half a mile, are all within walking distance of the hotel. If you like specialty shops, North Michigan Avenue, "the magnificient mile," has ladies' and men's wear, antiques, jewelry, silver, furniture, art, books, music, and virtually anything else you might like to shop for.

Members of the section think you'll like being in Chicago—and they're going to do their best to make this the case!

Nominations for Officers

Members of The Electrochemical Society have the privilege of suggesting to the Nominating Committee names of eligible candidates for officers of the Society. Such nominations should be submitted to the Secretary by April 15.

Suggestions for nominations should be confined to individuals who have been active in the affairs of the Society.

Enlarged Abstracts Booklet Published Again

The Electronics Division will again publish an "Enlarged Abstracts" booklet for the 1954 Spring Meeting of the Society at Chicago. The booklet will have 1000-word abstracts of most papers to be given before the Electronics Division in its symposia on *Instrumentation*, *Luminescence*, *Phosphor Screen Application*, *Rare Metals*, and *Semiconductors*.

Abstracts will contain pertinent information and experimental data given in the papers and will provide these details before publication, thus aiding workers in the field. The abstracts will be "printed but not published."

Enlarged abstracts booklets should be available about April 1; the price will be $2.00. Orders should be sent to: C. W. Jerome, Sylvania Electric Products Inc., 60 Boston Street, Salem, Massachusetts.

DIVISION NEWS

Electronics Division

The annual business meeting of the Electronics Division will be held at the Spring Meeting of the Society (May 2 to 6, 1954) in Chicago. The specific time and place is given in the last paragraph of this item.

During the year a merger of the Rare Metals Section with the Electrothermic Division was proposed. A mail ballot of the Division membership on the proposed merger and the necessary changes to the Division's bylaws was taken and at the end of the 3-month period prescribed by the bylaws, the vote stands at 88 in favor, 5 against. The favorable vote is in excess of the necessary two-thirds of those replying and, consequently, the merger is approved and the bylaws changed accordingly. The merger will take effect immediately following the meeting in Chicago.

A survey to determine the fields of interest of the membership elicited 129 replies. The breakdown of the replies by symposia was: Rare Metals—53; Instrumentation—51; Luminescence—69; Screen Application—49; Semiconductors—69.

The Nominating Committee (J. R. Musgrave, Chairman, E. G. Widell, and H. R. Harner) has selected the following nominees for officers during the 1954–55 term:

General Chairman—A. L. Smith, RCA Victor Division, Lancaster, Pa.

Group Chairman—H. Bandes, Sylvania Electric Products Inc., Bayside, N. Y.

Group Chairman (General Electronics)—A. E. Middleton, P. R. Mallory and Company, Indianapolis, Ind.

The term of Secretary-Treasurer (C. W. Jerome) has one more year to run. All nominees have given assurance of their willingness to serve.

The bylaws of the Division provide that additional nominations may be made by petition signed by 5 members of the Division. Such petitions must be in the hands of the Nominating Committee Chairman before the election and the nominees must give assurance of their willingness to serve.

The election will be held at the business meeting of the Division on Wednesday, May 5, at 12:30 P.M. in Parlor D at the LaSalle Hotel, Chicago.

C. W. Jerome, *Secretary-Treasurer*

SECTION NEWS

Cleveland Section

The January meeting of the Cleveland Section was held in conjunction with the National Association of Corrosion Engineers on January 19 at the Allerton Hotel. About 65 persons attended dinner prior to the meeting.

Chairman William Palmquist of the Corrosion group presided at the meeting. Dr. Maurice Van Loo, Director of Paint Research at the Sherwin-Williams Paint Laboratory in Chicago, spoke on "Filiform Corrosion."

Dr. Van Loo described in detail the manifestations of the filiform, a thread-like corrosion growth produced as the result of a defect in a protective coating on a metal surface. Such growths are unique in character as opposed to random rusting. The active growing heads of the filiform are ferrous while the body of the growth is ferric oxide. These growths are primarily governed by humidity and temperature. Dr. Van Loo illustrated his talk with slides and a movie including lapse time photography which showed actual growth of the filiform over long periods of time.

MERLE E. SIBERT, *Secretary*

Chicago Section

On December 10, the Chicago Section held its monthly meeting in the Chicago Engineers Club. Dr. M. A. Streicher, of the Engineering Research Department of the du Pont Company, spoke on intergranular corrosion with special reference to stainless steels.

He pointed out that the term intergranular corrosion is used to describe a wide range of phenomena, and said that corrosion may be defined as intergranular when rate of attack at grain boundaries significantly exceeds rate of attack at grain faces. For metals undergoing this type of attack, the rate of weight loss increases with time as metal grains are detached from the surface.

It was recalled that one of the methods used to test the susceptibility of a stainless steel to intergranular attack was to subject it to boiling 65% nitric acid. Steels subject to attack corrode at the grain boundaries, in hot nitric acid, with the formation of iron, chromium, and other nitrates. One of the most interesting points of the evening's talk was the discussion of the effect of chromium nitrate on stainless steels under the conditions of this test. Sensitized stainless steels, the speaker pointed out, ordinarily subject to intergranular attack, were not attacked in boiling nitric acid tests when the chromium nitrate concentration was kept down to only a few parts per million. Conversely, stabilized stainless steels, ordinarily not subject to intergranular attack, were attacked when the chromium nitrate concentration was sufficiently high.

Superimposed microphotographs of a given area revealed that intergranular attack was dependant upon grain orientation. Thus attack along one grain boundary may be more rapid than along another. Microphotographs were also used to show that pitting induced by anodic treatment in chloride solutions was initiated at grain boundaries in nearly all cases.

Discussion following the paper was entered into by many of those present and was indicative of the interest in this field.

A. H. ROEBUCK, *Secretary*

India Section

The India Section held a symposium on "Electroprocess Industries" at the FACT colony school, Alwaye, on November 22 and 23, 1953, with the cooperation of M/s Travancore-Cochin Chemicals, Fertilisers & Chemicals, Travancore, and Indian Aluminium Company, Alwaye. The following papers were presented: (*a*) "Operation and Characteristics of Krebs Mercury Cells for Electrolytic Alkali-Chlorine" by V. Paniker, (*b*) "Brine Purification System in the Operation of Mercury Cells for Electrolytic Alkali-Chlorine" by A. Natarajan, (*c*) "Ferro-Manganese Industry in India" by P. S. Narayana, (*d*) "Electrolytic Production of Magnesium Metal in India Employing Dolomite and Bitterns as Raw Materials" by V. Aravamuthan, and (*e*) "Electroplating: Some Recent Developments and Future Possibilities" by T. L. Rama Char.

There was a large gathering drawn from research laboratories and industrial establishments. Visits were arranged for the 3 factories mentioned above and M/s Travancore Rayons Ltd., in the Alwaye area. The program was rounded off with social functions arranged by Messrs. Travancore-Cochin Chemicals and the Section.

T. L. RAMA CHAR. *Regional Editor*

NEW MEMBERS

In January 1954 the following were elected to membership in The Electrochemical Society:

Active Members

ROBERT J. AGNEW, The Texas Co., Box 509, Beacon, N.Y. (Corrosion)

JOHN D. CHRISTIAN, Research Dept., Monsanto Chemical Co., Texas City, Texas (Electro-Organic)

RICHARD E. DURTSCHI, Battelle Memorial Institute, mailing add.: 326 South Eureka Ave., Columbus, Ohio (Electrothermic)

ANTHONY J. KOLK, JR., Horizons Inc. 2891 E. 79 St., Cleveland, Ohio (Theoretical Electrochemistry)

CHARLES LEVY, Watertown Arsenal Laboratory, Watertown, Mass. (Electrodeposition)

BERNARD PORTER, Kaiser Aluminum and Chemical Corp., Reduction Group, Permanente, Calif. (Electrodeposition and Industrial Electrolytic)

WILLIAM M. RAYNOR, Foote Minerals Co., mailing add.: 8204 Seminole Ave., Philadelphia, Pa. (Electronics)

GEORGE P. SEMELUK, General Electric Co., mailing add. 18032 Euclid Ave., Cleveland, Ohio (Electronics)

FRANK E. SWINDELLS, E. I. du Pont de Nemours & Co., Inc., mailing add.: 11 Garthwaite Terrace, Maplewood, N.J. (Electronics)

PALMER W. TOWNSEND, Air Reduction Co., mailing add.: %Lydecker, R. D. 2, Bound Brook, N.J. (Corrosion)

Student Associate Member

LALGUDY J. BALASUNDARAM, E. 68, Hostel, Indian Institute of Science, Bangalore, India (Corrosion and Electrodeposition)

Resignations

T. R. ANANTHARAMAN, Trinity College, Oxford, England

HOWARD A. BEWICK, 512 Bronson Rd., Syracuse, N.Y.

ARTHUR BLOOMBERG, P.O. Box 89, Linden, N.J.

HOWARD Y. CLYMER, 318 Park Ave., Swarthmore, Pa.

PERSONALS

CORTEZ P. HACKETT, Solvay Process Division, Allied Chemical & Dye Cor-

poration, Syracuse, New York, has been appointed director of development of the company. In his new post, Mr. Hackett heads engineering, research, and construction departments of Solvay. He will continue to make his headquarters at Syracuse.

ANDREW C. HOLM has been promoted to superintendent of the Carbide Division, Shawinigan Chemicals, Ltd., Shawinigan Falls, Canada.

HERBERT R. HANLEY, professor emeritus of metallurgical engineering at the University of Missouri, Rolla, Mo., recently left the United States for the Orient. An outstanding authority on nonferrous metals, he was selected by Purdue University to organize a department of nonferrous metallurgy in the University of Taiwan, Taiwan, Formosa.

GEORGE B. HOGABOOM

George B. Hogaboom, Emeritus member of The Electrochemical Society and national authority on electroplating, died at the age of 79 on December 31, 1953.

A descendant of early Dutch settlers, Mr. Hogaboom was born in Brooklyn, New York. He attended schools in the metropolitan area and was graduated from Newark Technical Institute in 1910. For a time he was a student of Thomas A. Edison at the inventor's laboratory in Orange, New Jersey. He worked in various supervisory capacities in the plating department of the International Silver Company, and for several years was head of the plating department of the P & F Corbin Division of the American Hardware Corporation. He was associated with several other firms in Connecticut and with the Hanson-Van Winkle-Munning Company in Matawan, New Jersey, and also acted as a consultant.

Mr. Hogaboom served the government during both World Wars as a technical advisor in the Bureau of Standards and with the War Production Board.

Outstanding among his numerous contributions to the literature of the electroplating industry is the book "Principles of Electroplating and Electroforming," written in collaboration with Dr. William Blum. The first edition appeared in 1924 and the third edition came out in 1949; it is one of the classics in its field. Mr. Hogaboom was a former associate editor of *The Metal Industry* and a frequent contributor to many magazines in his field.

GEORGE B. HOGABOOM

Mr. Hogaboom became a member of The Electrochemical Society in February 1911 and was made an Emeritus member in 1948. He was well known to everyone in his field and was active in the Electrodeposition Division and in the affairs of the Society, serving as a Manager of the Society from 1932–1934. Mr. Hogaboom was also a member of the American Electroplaters' Society, the American Chemical Society, the American Society for Testing Materials, and the Electrodepositors' Technical Society of England.

Mr. Hogaboom is survived by his wife, Emma, of New Britain, Connecticut, and three children, G. Byron Hogaboom, Jr., of Kenilworth, New Jersey, Ovide Hogaboom of Newington, Connecticut, and Mrs. Charles Crockett of Manchester, Connecticut.

He will be sadly missed by family, friends, and members of the Society.

BOOK REVIEWS

SCHWEFEL, System number 9, Teil A, Lieferung 2 (SULFUR, System No. 9, Section A, Part 2) of the 8th edition of GMELIN'S HANDBOOK OF INORGANIC CHEMISTRY. Edited by the Gmelin Institute. Published by Verlag Chemie, GmbH., Weinheim/Bergstrasse, West Germany, 1952. 450 pages, 76 graphs, $35.30.

SCHWEFEL, System number 9, Teil B, Lieferung 1 (SULFUR, System No. 9, Section B, Part 1) of the 8th edition of GMELIN'S HANDBOOK OF INORGANIC CHEMISTRY. Edited by the Gmelin Institute. Published by Verlag Chemie, GmbH., Weinheim/Bergstrasse, West Germany, 1953. 372 pages, 75 graphs, $29.40.

These sections of the eighth edition of Gmelin's Handbook are recent additions to the Gmelin Institute's presentation of the chemistry of sulfur. They are written in the same style and format as previous volumes of Gmelin.

Section A, Part 2, begins with an exhaustive survey of the occurrence of sulfur in the universe and should be of interest to astronomists, geophysicists, and botanists, as well as chemists. There follows a review of the derivation and processing of elemental sulfur, hydrogen sulfide, and sulfur dioxide. A large section is devoted to sulfuric acid, sulfur trioxide, and chlorosulfonic acid. The last two chapters are on colloidal sulfur and the known physiological effects of sulfur and a few sulfur compounds.

The entire text of Section B, Part 1, is devoted to the hydrides and oxides of sulfur. The rather complicated chemistry of these substances is presented in detail, together with an excellently presented, and unusually large, amount of physicochemical data. The clear presentation of the physicochemical data is one of the best features of this work.

Each volume includes a table of contents which has enough entries to be really useful for finding information, and the number of graphs and figures in both volumes is unusually large for a reference work of this type. The number of references to publications listed, and the continuity of the text, cause one to be deeply impressed by the tremendous amount of labor required to compile, organize, and present the information in these volumes.

The prices of these books are probably prohibitive for most individuals, but scientific libraries will find them a necessity.

Gmelin plans to complete the review of sulfur with Section A, Part 3 and Section B, Part 2, to be issued in the near future.

J. W. NIELSEN

LETTER TO THE EDITOR

Effect of Stress on Metal Electrode Potentials

Dear Sir:

In the discussion of the results of the paper by Fryxell and Nachtrieb,[1] I fail to see a very probable explanation of the phenomena observed. Shouldn't we assume a slight decrease in the activity of the metallic surface during tension

[1] R. E. FRYXELL AND N. H. NACHTRIEB, *This Journal*, **99**, 499 (1952).

and an increase in activity during compression?

I visualize the activity of the electrode material in terms of "number of atoms exposed to the solution per unit area." If a tensile stress is applied to an electrode, the number of metallic atoms per unit area exposed to the solution will be decreased. The initial state will tend to be maintained by either a plastic deformation of the stressed sample or by deposition of silver from the solution. The latter effect then will tend to make the stressed electrode more noble with respect to the standard, as the authors find. Of course, in the compression experiment the reverse is expected, as is experimentally observed.

The magnitude of these potential differences between standard and stressed or compressed electrodes will be given by the equation:

$$E = -\frac{RT}{n\mathbf{F}} \ln a$$

where a is the activity of the stressed (or compressed) electrode. The authors give an average "tension coefficient" for the silver electrode potential as 0.078 ± 0.021 mv/1000 psi. Substituting this value of E in the above equation, we find:

$$a = 0.997$$

It is reasonable to assume that at low stresses (below the elastic limit) there is insignificant dimensional change perpendicular to the direction of the applied stress. Thus, the 0.3% reduction in "surface activity" corresponds to 0.3% elongation of the electrode in the direction of the applied stress (1000 psi).

From stress-strain data on silver wire it is found that a stress of 1000 psi will cause an elongation equal to ca 0.3%. The agreement of the measured elongation with the calculated elongation from the measured "tension coefficient" for the silver electrode potential substantiates the hypotheses set forth at the beginning of this letter.

As for the "indicator electrode," the results obtained by the authors are expected, since the activity of the inert electrode is not involved in the electrochemical equations.

D. N. Staicopoulos
Marshall Laboratory,
E. I. du Pont de Nemours & Co.,
Philadelphia, Pa.

* * *

RECENT PATENTS

Selected for electrochemists by Fred. W. Dodson, Chairman of the Patent Committee, from the Official Gazette.

November 10, 1953

Parkinson, N., 2,658,866, Electrodeposition of Tin-Nickel Alloy
Little, J. D., 2,658,867, Electrodeposition of Nickel
Collison, R. G., 2,658,868, Ozone Generator
Chubb, M. F., 2,658,935, Cuprous Chloride Electrode
Rock, A. F., 2,658,936, Dry Cell Battery
Chapman, E. S., 2,658,937, Electrical Storage Battery
Robillard, A. A., 2,658,938, Accumulator Battery

November 17, 1953

Cusano, D. A., and Studer, F. J., 2,659,678, Transparent Luminescent Screen and Method for Preparing Same
Koller, L. R., 2,659,679, Phosphor Coating Process
Lafferty, J. M., 2,659,685, Boride Cathodes
Konig, W., 2,659,764, Furnace and Process for Electrically Melting Glass
Anderson, W. T., Jr., 2,659,833, Ultraviolet Vapor Electric Discharge Device
Rudolph, H. A., 2,659,846, Selenium Element and Method of Making It

November 24, 1953

Rohrman, F. A., 2,660,514, Removal of Nitrogen from Mixtures of Combustible Gases
Putnam, C. W., 2,660,539, Method for Producing A Fluorescent Screen
Karash, W. J., and Foote, A. G., 2,660,540, Metal Vaporizer and Method for Vapor Coating
Ostrow, B. D., 2,660,554, Bright Gold and Gold Alloy Plating Baths
Schloen, J. H., and Ekler, K., 2,660,555, Process of and Electrolyte for Refining Copper
Butler, D. G., 2,660,556, Electric Arc Production of Combustible Gases
McKeag, A. H., 2,660,565, Manganese Activated Cadmium Lithium Silicate Phosphor
Froelich, H. C., 2,660,566, Electroluminescent Zinc Sulfide Phosphor
Duncan, O. G., 2,660,611, Nonspillable Vent Plug for Storage Batteries
André, H., 2,660,695, Low Voltage Electrochemical Condenser of High Specific Gravity
Lauckner, H. E., 2,660,697, Selenium Rectifier with Varnish Intermediate Layers
Black, D. W., 2,660,698, Selenium Rectifier

December 1, 1953

Smith, E. J., 2,661,328, Method of Flow-Brightening Tinplate
De Long, H. K., 2,661,329, Method of Treating Electroplated Magnesium Castings
Sullivan, F., 2,661,330, Method of Electropolishing Sterling Silver
Howard, E. G., Jr., 2,661,331, Photopolymerization Process
Lincoln, A. J., and Courtright, G. D., 2,661,385, Muffle Type Furnace
Lundgren, G. T., 2,661,386, Retort Type Sectional High-Frequency Furnace
Ackermann, K., and Schlecht, L., 2,661,387, Porous Electrode Plates and Process for Making Such Articles
Warner, A. J., and Gobat, A. R., 2,661,388, Primary Cells
Johnson, J. M., 2,661,463, Battery Terminal Clamp

December 8, 1953

Uhlig, E. C., and Murray, L. A., Jr., 2,662,032, Process of Making a Battery Separator
Passal, F., 2,662,054, Method of Electrodepositing Chromium Directly on Aluminum
Kroger, F. A., 2,662,060, Self-Activated Zinc Sulfide Phosphors
Southern, R. L., 2,662,104, Feed and Current Supply Apparatus for Consumable Electrodes and Method of Operating Furnaces Using the Same
Uhlig, E. C., and Murray, L. A., Jr., 2,662,106, Battery Separator
Uhlig, E. C., and Murray, L. A., Jr., 2,662,107, Battery Separator
Coates, A., 2,662,108, Filling and Venting Means for Electric Batteries
Marko, A., and Kordesch, K., 2,662,211, Device for Measuring the Discharge Voltage of Galvanic Cells

December 15, 1953

Krause, P. W., 2,662,829, Liquid Settling of Fluorescent Screens
Darlaston, A. J. H., 2,662,830, Settling of Fluorescent Screens
Middleton, A. E., and Mengali, O. J., 2,662,832, Process of Producing An Electro-Photographic Plate
Teal, G. K., 2,662,852, Preparation of Two-Sided Mosaic Screen

Ellis, D. G., 2,662,853, Electrodeposition of Nickel

Miescher, K., and Schmidlin, J., 2,662,854, Photochemical Preparation of 17,20-Hydroxy-Ketones of the Pregnane Series

Brennan, J. B., 2,662,928, Storage Battery Electrode

Dague, H. F., 2,662,929, Method of Manufacturing Battery Separators and the Like

December 22, 1953

Middleton, A. E., 2,663,636, Electrophotographic Plate and Method of Producing Same

Pierce, W. J., 2,663,684, Method of and Composition for Plating Copper

Levy, G. B., 2,663,685, Electrolytic Production of Dihydro-Streptomycin and Salts Thereof

Lloyd, R. R., Rosenbaum, J. B., and Homme, V. E., 2,663,686, Production of Electrolytic Chromium from Ferrochrome

Bailey, E. I., 2,663,687, Electric Treater

Warner, A. J., and Gobat, A. R., 2,663,749, Primary Cell

Paillet, R., 2,663,750, Flat Cell Electric Battery

Bashara, S. F., 2,663,751, Water Replenishing Device for Storage Batteries

Homer, H. H., 2,663,816, Electric Discharge Lamp

Klein, O. J., 2,663,831, Selenium Dry-Disk Rectifier

Peterson, O. L., 2,663,854, Battery Cable Clamp

Anthony, R. P., 2,663,862, Battery Indicator

December 29, 1953

Fabaron, P. F., 2,664,351, Manufacture of Manganese

Blackburn, N. F., 2,664,392, Nickel Plating

Mathers, F. C., and Lantz, G. B., 2,664,393, Electrolytic Refining of Lead

Reeves, W. B., 2,664,394, Electrochemical Conversion of Hydrocarbons

Lang, M., 2,664,453, Battery Electrode

LITERATURE FROM INDUSTRY

EXPANSION-TYPE BELLOWS. Bulletin No. 300 describes a special type of metal expansion bellows for conveying gas and liquids. Text and diagrams explain the welded-diaphragm construction of the bellows and point out how this results in a bellows especially able to

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Acid Oxalic, 1/10 N, 1/100 N	2.25
Acid Sulphuric, 1 N, 2/3 N, 1/2 N, 5/28 N, 1/16 N, 1/25 N, 1/28 N, 1/50 N	1.85
Acid Sulphuric, 1/10 N	1.50
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Ammonium Thiocyanate, 1 N, 1/2 N, 1/4 N, 1/10 N	2.50
Barium Chloride, 1/2 N	3.00
Barium Chloride, 1/5 N	2.75
Barium Chloride, 1/10 N	2.00
Bromine (Bromate-Bromide, 1/10 N	3.00
Ceric Sulphate, 1/10 N	4.50
Ferrous Ammonium Sulphate, 1/10 N	2.75
Iodine (Iodine-Iodide, 1/5 N, 1/20 N, 1/100 N	2.50
Iodine (Iodine-Iodide), 1/10 N	2.25
Iodine (Iodate-Iodide), 1/10 N	5.00
Iodine (Iodate-Iodide, 1/20 N	3.75
Potassium Bichromate, 1/2 N	2.25
Potassium Bichromate, 1/10 N	1.75
Potassium Bromate, 1/10 N	2.50
Potassium Bromide, 1/10 N	2.50
Potassium Biiodate, 1/100 N	3.50
Potassium Carbonate, 1/10 N, 1/16 N	2.00
Potassium Ferrocyanide, 1/10 N	2.75
Potassium Hydroxide (CO_2 free), 1 N, 1/2 N, 1/4 N	2.15
Potassium Hydroxide (CO_2 free), 1/10 N	1.90
Potassium Iodate, 1/10 N, 1/100 N, 0.0312 N	2.50
Potassium Permanganate, 1/4 N, 1/5 N	2.25
Potassium Permanganate, 1/10 N, 1/16 N, 1/20 N, 1/50 N, 1/100 N	2.00
Potassium Thiocyanate, 1/10 N	2.50
Silver Nitrate, 0.282 N	5.00
Silver Nitrate, 1/10 N, 0.0282 N	2.50
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Sodium Carbonate, 1/10 N	1.50
Sodium Carbonate, 1/100 N	1.65
Sodium Chloride, 1/10 N	2.00
Sodium Hydroxide (CO_2 free), 1 N, 1/2 N, 1/4 N, 1/5 N, 1/20 N, 1/50 N, 1/100 N	2.15
Sodium Hydroxide (CO_2 free), 1/10 N	1.90
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GFB-NBS Strain Tester. Information Bulletin 100.49.1 gives data on the new GFB-NBS Strain Tester, an automatic precision testing machine for the evaluation of rubber and rubberlike compounds. Developed and constructed in 1948 in close cooperation with the National Bureau of Standards, it has satisfied the most exacting requirements in production and laboratory control and testing programs of quality organizations. G. F. Bush Associates. P-189

"HOKE." New 66-page catalogue describes the complete line of small valves, pressure regulators, stainless steel cylinders, flo-gages, and oxy-gas torches of the manufacturer. Includes a numerical index, engineering data, and information on accessories and fittings. Hoke, Inc. P-190

Silicon Carbide. 52-page brochure entitled "Facts About Silicon Carbide" discloses the properties of silicon carbide as related to abrasive applications, and outlines manufacturing techniques. An extensive bibliography is also given. The Carborundum Co. P-191

Sodium and Potassium Silicates. New folder, available to the metal industries, describes the use of silicates in sealing porous castings, cast metal molding, and investment casting cements. Miscellaneous silicate applications include the use in the new electro-erosive process, for grinding and cutting tool steel by means of an electric arc, wire drawing, and metal cleaning. Philadelphia Quartz Co. P-192

Wet Blasting Machine. Illustrated bulletin gives complete general specifications on the new Model 30 Liquamatte wet blasting machine. The Liquamatte is designed for all sorts of precision cleaning and finishing operations involving small parts which can be lifted and handled manually. Some typical applications for the machine are: heat treat scale removal; fine deburring; reconditioning of valves, pistons, rods, etc.; reconditioning plant equipment; cleaning oxides from tungsten carbide tips before brazing them to cutting tools. American Wheelabrator & Equipment Corp. P-193

Calrod* Heating Catalogue. A 1954 edition of the catalogue on Calrod electric heaters and heating devices has been announced. The 60-page, 2-color booklet describes the units in terms of application, special features, installation, and pricing. More than 175 photographs and drawings illustrate the various products. Indexed by processes and application, the catalogue contains methods for determining power requirements and heat losses for many applications. General Electric Co. P-194

Research Annual. Some of the year's most notable scientific accomplishments by Columbia University scientist-engineers are detailed in the "Columbia Research News Annual," published recently. The "Annual" covers diverse fields of science and engineering from structure of the atomic nucleus to prescription plastics, from nucleic acids to effect of trace metals of tobacco. The 30-page illustrated booklet is up to date, factual, and written in a popular style; it is a compilation of the "Columbia Research News," a newsletter published by the Committee of Science and Engineering Research, School of Engineering, Columbia University. P-195

Optical Pyrometer. New bulletin (Catalogue No. 85), available upon request, gives detailed information on the PYRO Optical Pyrometer. Also features technical information on the principles of optical pyrometry, illustrations of applications, and other interesting data. The Pyrometer Instrument Co., Inc. P-196

Spray Nozzle Catalogue. A comprehensive, industrial spray nozzle catalogue has just been printed. Thousands of standard and special industrial spray nozzles are illustrated and described. For each nozzle, complete data is listed covering capacity and spray angle. Dimentional specifications for all standard nozzles are also given. In addition, information is supplied on a wide variety of related equipment, such as line strainers, elbows, check valves, and adjustable joints. For handy use by the engineer, tables are included on spray coverage and pipe frictions. Spraying Systems Co. P-197

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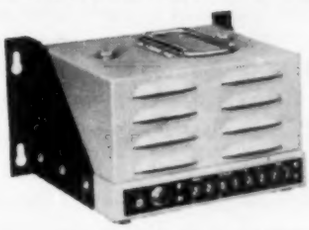
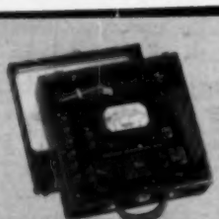
Model 697 Volt-Ohm-Milliammeter

One of a line of pocket-size meters, Model 697 combines a selection of a-c and d-c current, and resistance ranges. Ideal for maintenance testing and many inspection requirements.



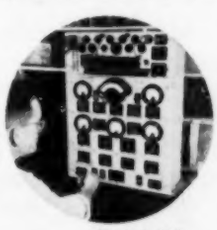
Model 1411 Inductronic D-C Amplifier

Stable amplifier provides high degree of resolution even at fractional loads. Reaches steady full scale deflection in a fraction of a second. Interchangeable plug-in range standards for either microamperes or millivolts.



Industrial Circuit Tester — Model 785

A multi-range, multi-purpose, ultra-sensitive analyzer, for laboratory and industrial checking of electrical and electronic circuits. Has 28 practical scale ranges; measures d-c and a-c voltage, d-c and a-c current, and resistance. Accessories available to extend ranges. Compact and portable; furnished in either oak or steel case.



Model 686
Electronic Tube Analyzer

Tests tubes under exact operating potentials. Accurately determines true mutual conductance of all tubes, in accordance with manufacturers' rated operating conditions, or under special operating conditions.

High Frequency Electronic Analyzer
Model 769

A three-in-one instrument providing a self-contained Volt-Ohm-Milliammeter, a high impedance electronic D-C Volt-Ohmmeter, and a probe type Vacuum Tube Voltmeter for use to 300 megacycles. Exceptionally stable and accurate. Has specially designed extremely small RF and D-C probes.

NEW PRODUCTS

PEAK VOLTMETERS. Sensitive Research peak voltmeter units provide a convenient means for converting any Sensitive Research R.M.S. reading electrostatic voltmeter to an accurate peak reading voltmeter which takes a negligible amount of power from the circuit under measurement. Two important functions performed by the units are: rectify voltage being measured, and store peak value so that it may read on an instrument scale. Sensitive Research Instrument Corp. N-50

CORROSION RESISTANT FILTER. Compact in-line filters, long in demand for highly corrosive materials such as fuming nitric acid, hydrogen peroxide, and hydrochloric acid, are now available. The filter medium is porous Kel-F which is completely resistant to all common acids and gases in all concentrations, as well as to common organic chemicals. It has a tensile strength of 900 psi and a modulus of elasticity of 18,000 psi. Standard porous Kel-F filter elements will remove all particles larger than 5 microns in liquid filtration, and much finer particles in gas filtration; can be used at temperatures up to 350°F; and are resistant to thermal shock. Porous Plastic Filter Co. N-51

SUPER-SENSITIVE RELAY. Rugged super-sensitive relay (Style SS-1-O.D.) has a wider range than any similar unit. Essentially a d-c relay, this unit is also furnished with built-in selenium rectifiers for a-c duty. Can also be provided in hermetically sealed construction. Unusual range of operating and construction characteristics adapts the unit to plate relay service, aircraft relay service, and all applications where dependable performance at minimum power-demands must be provided. Techniflex Corp. N-52

NEW TAPER TECHNIQUE. A taper technique that eliminates terminal screws or soldering in electrical circuits has been developed. Both self-locking terminals, the Taper Pin with mating receptacle and the flat Taper Tab and Taper Tab Receptacle were designed primarily for the electronics and communications fields where many connections have to be made and space is limited. The small size of the Taper Pins permits very close spacing of termination without danger of short circuits. Aircraft-Marine Products, Inc. N-53

SIDE INDICATING PANEL METERS. A new line of miniature side indicating panel meters has been announced. Developed to obtain greater legibility for complex instrument panels, these meters provide maximum scale length with minimum panel area. Available in a wide variety of ranges with flanges for single and back-to-back mounting. Have an accuracy of ±3% of full scale deflection on d.c. and ±5% on a.c.; meet practically every electrical measuring requirement. International Instruments, Inc. N-54

INDUSTRIAL X-RAY FILM. A new ultra-fine grain industrial x-ray film (Type 510), designed for use without calcium-tungstate intensifying screens, has been developed. Can be used at low voltages to examine low-opacity materials, such as aluminum, magnesium, corn, and wheat. Can be used to particular advantage on subjects where very minute detail is desired, since the fine grain emulsion permits detection of tiny flaws in, for example, spot-welding in aluminum sheeting. Du Pont Photo Products Dept., E. I. du Pont de Nemours & Co. N-55

TEFLON MOLDED O-RINGS. O-Rings of Teflon are now being molded (Teflon is DuPont's trademark for its Polytetrafluorethylene Resin, the plastic that is practically chemically inert, nonadhesive, and can be used for a range of temperature of −320° to 500°F). Reportedly, quality and uniformity of O-Rings by the molding process are excellent. The Sparta Heat Treat Co. N-56

MINIATURE SHIELDED CABLES. Tensolite super-flexible miniature shielded cables are now available with a tough outer jacket of Teflon (DuPont's trade mark for its Polytetrafluorethylene Resin). This jacket provides outstanding protection against mechanical damage, at the same time electrically insulating the metallic shield from surrounding objects. Supplied in many standard constructions, including single and multiconductor types; permit continuous operation at temperatures from −90° to +250°C with maximum operating voltages to 1000 volts rms. Feature extreme flexibility, ease of stripping, high dielectric strength, plus extreme temperature range. Tensolite Insulated Wire Co., Inc. N-57

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Position Wanted

RESEARCH CHEMIST, M. S., age 33. Physical and organic chemistry background. Business administration training, Alexander Hamilton Institute. Six years' diversified industrial experience. Selenium rectifiers, germanium rectifiers, electrochemistry, and fine organics. Desires interesting position in the New York-New Jersey-Connecticut area. *Reply to Box 354.*